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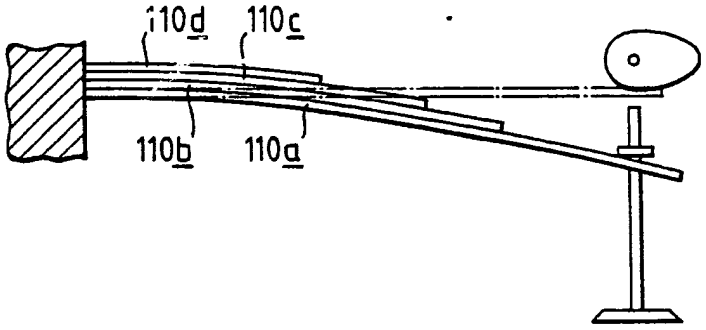
(54) Title: CAM FOLLOWER MECHANISMS



(57) Abstract

A cam follower mechanism, particularly for use with an internal combustion engine valve gear, has a cam follower (19) constrained towards contact with a cam (17) by a spring (30). A restraint (40) holds the spring in a partially loaded condition, whilst the cam follower lies adjacent a low (52) of the cam, the restraint being such that the spring is lifted clear thereof as the cam follower rides towards a high (54) of the cam.

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CAM FOLLOWER MECHANISMS

The present invention relates to cam follower mechanisms and in particular to such mechanisms as used in the operation of valves in machines such as reciprocating engines and compressors.

A typical reciprocating internal combustion engine or compressor has at least one valve which is operated to allow fluid to enter and to exit from a cylinder. Most modern machines of this type have at least one separate inlet and outlet, each with its own valve, for each cylinder. Each valve is operated either directly or through an intermediary mechanism such as, for example, a rocker assembly to open and close, according to a predetermined programme based on the design of a particular machine, by a cam mounted on a shaft geared to rotate in synchronism with a main drive (for an engine) or driven (for a compressor) shaft.

When a cam is activating a mechanism that part of the mechanism in contact with the cam, known as the cam follower, must be constrained to remain in contact with the cam. This is to ensure that the mechanism returns to the correct position after each cam operation. The constraining force must also be sufficient to ensure that damaging intermittent contact does not occur between the cam and cam follower during a single operation. The presence of a constraining force increases friction effects and is a cause of wear. Also energy must be expended to overcome the friction.

In the case of valve mechanisms for internal combustion engines and compressors the constraining force is conventionally supplied by a coil spring acting on each valve to return it to a closed position. With the nature of this type of spring the force exherted is proportionate to the compression of the spring and is greater, so causing the greatest frictional force between the cam and cam follower, when the valve is fully open. The contact between cam and cam follower is conventionally sliding contact. It has been found that the energy consumed in overcoming friction between cams and cam followers is significant when compared with the operating characteristics of the machine.

According to the present invention a cam follower mechanism has a cam follower constrained towards contact with a cam by a spring and is characterised by a restraint holding the spring in a

partially loaded condition whilst the cam follower lies adjacent a low of the cam, the restraint being such that as the cam follower rides towards a high of the cam the spring is lifted clear of the restraint and a spring rate of the spring is reduced.

In a preferred form of the invention the spring consists of a resilient member having a C-portion with two arms extending therefrom and the restraint is a solid member which contacts the resilient member adjacent the C-section and which holds the spring in a partially loaded condition.

One form of restraint is a generally C shaped flange extending from a plate.

Alternatively the spring can be of cantilever or of leaf form.

Advantageously the spring and restraint can be formed from Fibre Reinforced Plastic material to provide an arrangement having lower weight than similar arrangements formed from conventional metallic spring materials.

Some embodiments of the invention will now be described, by way of example only, with reference to the accompanying diagrammatic drawings, of which:

Figure 1 is an elevation, in section, of a conventional valve arrangement for a reciprocating machine such as an internal combustion engine or a compressor,

Figure 2 is a graph illustrating the characteristics of a typical spring as used in the arrangement of Figure 1,

Figure 3 is a side elevation, partly in section, of a valve arrangement according to one embodiment of the invention, with the valve closed,

Figure 4 is an end elevation, in direction X of Figure 3, of a detail of the arrangement illustrated in Figure 3,

Figure 5 is a side elevation of the embodiment of Figure 3 with the valve closed,

Figure 6 is a graph illustrating the characteristics of the spring used in the embodiment of the invention illustrated in Figures 3 to 5, and

Figures 7 and 8 are side elevations of alternative springs for use in further embodiments of the invention.

A conventional valve arrangement for a machine in which reciprocating movement is converted into rotary movement, or vice versa, is illustrated in Figure 1. A valve head 10 mounted at a first end 11 of the valve stem 12 is slideable relative to a cylinder head 13 and is constrained by a coil spring 14 acting between the cylinder head 13 and a spring attachment 15 secured to the valve stem 12 towards a closed position in which the valve head 10 sealingly contacts a valve seat 16.

A cam 17 mounted on a cam shaft 18 which is synchronously connected to a rotating part of the machine (not shown) acts against a cam follower in the form of a second end 19 of the valve stem 12 causing the valve head 10 to move into and out of contact with the valve seat 16. With the valve open and the valve head 10 and the valve seat 16 separated fluid is allowed to enter or leave the cylinder head 13 via a port 20.

The coil spring 14 has a constant spring rate, as is shown in Figure 2 which is a graph of load W against spring displacement (one end relative to the other) d. Thus as the valve head 10 moves from a closed position C through a distance d, to a fully open position O the load tending to close the valve increases by an amount W_1. As shown by Figure 2 there is a positive load on the valve stem 12 when the valve head 10 is in contact with the valve seat 16. This is to ensure that the cam follower (the second end 19 of the valve stem 12) remains in contact throughout the valve operating cycle and also to ensure that the valve head 10 remains firmly in contact with the valve seat 16 when the valve is closed. When the valve is not being operated there is a gap between the cam 17 and cam follower 19. This allows the valve to close even if there is some wear in the valve head 10, valve seat 16 or both.

In a valve mechanism including a cam follower mechanism according to the invention (Figures 3 to 5) the valve mechanism, cylinder head and cam are similar to those in the conventional arrangement as described above with reference to Figure 1. The coil spring 14 of the conventional mechanism is replaced by a spring illustrated generally at 30 which has a resilient member having a C-portion 3 from which extend two arms 31, 33 each having adjacent an end remote from the C-portion 20 a hole 34, 35 respectively through which

passes the valve stem 12.

A restraint in the form of a solid member having a C shaped plate 40 from the curved extremity of which extends a flange 41, best seen in Figure 4, contacts the resilient member adjacent the C-section 30. The resilient member is thereby held in a partially loaded condition such that the arms 32, 33 are deflected from unloaded positions indicated by the dotted outlines at 32a, 33a. The solid member is rotatably mounted on a pivot 42 secured to structure (not shown) which is fixed relative to the cylinder head 13.

One arm 33 of the resilient member bears against a stop 50 which is mounted on structure (not shown) fixed relative to the cylinder head 13 whilst the other arm 34 bears against a stop 51 secured to the valve stem 12. The arrangement is such that when the valve is closed and the valve head 10 is seated in the valve seat 16 the cam follower end 19 of the valve stem 12 lies adjacent a low 52 of the cam 17 with a small gap 53 therebetween.

In operation as the cam shaft 18 and cam 17 rotate the cam comes into contact with the cam follower 19 which starts to ride towards a high 54 of the cam 17, the high position being illustrated in Figure 5. Initially the resilient member takes up the valve motion by deflection of the arms 32, 33 between the flange 51 and an end 55 of the flange 41 and between the stop 50 and an end 56 of the flange 41 respectively. The spring rate is therefore similar to that illustrated in Figure 2 and, as illustrated in Figure 6 follows the line 6 (corresponding to the valve closed position) I.

However a condition is reached (corresponding to point I in Figure 6) where the arms 32, 33 are deflected to an extent where the partial load is taken up and the resilient member over much of the C section moves away from the flange 41, as is clearly illustrated in Figure 5. The load is then applied over a greater resilient length and in accordance with the well-known characteristics of springs the spring rate is reduced. The spring rate as the valve moves from the position corresponding to point I in Figure 6 to the fully open position O is therefore less than it was for movement from C to I. After a given valve movement d_1, equal to the valve movement d, of the conventional arrangement illustrated in Figure 1, the total

pressure W^1, between the cam follower 19 and cam 17 is less than that, W_1, for the conventional arrangement. This can be clearly seen by comparing Figures 2 and 6.

In practice this reduction in pressure significantly reduces the power required to drive the cam mechanism against friction effects.

It will be realised that by suitable shaping of the plate 40 and flange 41 the resilient member can be adapted to move progressively out of restraining contact to provide a variable spring rate as illustrated by the dotted line in Figure 6.

In an alternative embodiment of the invention (Figure 7) a cantilever spring 100 secured to structure 101 fixed relative to a cylinder head (not shown in this Figure) is constrained by a stop 12 from an unloaded position 100a. The spring acts against a flange 51 and the operation is similar to that of the spring described above with reference to Figures 3 to 6. By using a series of stops 102 a variable spring rate can be obtained.

Yet another embodiment of the invention (Figure 8) uses a leaf spring having a number of leaves such as those shown at 110a, 110b, 110c and 110d. Some or all of the shorter leaves are curved in their unloaded condition so holding a longest cantilever spring 110a in a loaded position. Again operation is similar to that described with reference to Figures 3 to 6, though it will be realised that this embodiment is particularly suitable for situations requiring a variable spring rate.

It will be realised that, whilst the invention has been described with respect to valve mechanism wherein the cam acts on a cam follower which is one end of the valve stem, the invention is equally applicable to arrangements wherein the cam drives the valve by means of an intermediate mechanism. Intermediate mechanisms, such as those involving push rods and rocker arms, are well known to those skilled in the arts of, inter alia, internal combustion engines and compressors, and will not be described herein.

It will also be realised that the invention is also suitable for other cam follower mechanisms, particularly such mechanisms in which the power required to overcome frictional effects is a significant proportion of an overall power consumption.

In the embodiments of the invention as described above with reference to Figures 3 to 5 the restraint can alternatively be a stiff C-shaped member corresponding to the flange 41, or such a member with a stiffening flange. As yet another alternative the C-shaped member can be replaced by a plurality of pegs.

It will, of course be realised that the above described conventional valve arrangement as illustrated in Figure 1 and the embodiments of the invention as described with reference to Figures 3 to 5, 7 and 8 are not intended as practical arrangements for actual use in an engine. As the invention is not concerned with valve arrangements as such the arrangements have been deliberately simplified to allow the description to concentrate on the invention.

CLAIMS

What is claimed is

1. A cam follower mechanism having a cam follower (19) constrained towards contact with a cam (17) by a spring (30) and characterised by a restraint (40) holding the spring in a partially loaded condition whilst the cam follower lies adjacent a low (52) of the cam, the restraint being such that as the cam follower rides towards a high (54) of the cam the spring is lifted clear of the restraint and a spring rate of the spring is reduced.

2. A cam follower as claimed in Claim 1 characterised in that the spring (30) consists of a resilient member having a C-portion (31) with two arms (32, 33) extending therefrom and the restraint (40) is a solid member which contacts the resilient member adjacent the C-section.

3. A cam follower as claimed in Claim 2 characterised in that the restraint (40)is a C-shaped member.

4. A cam follower as claimed in Claim 1 characterised in that the spring consists of a resilient member (100) in the form of a cantilever.

5. A cam follower as claimed in Claim 1 characterised in that the spring consists of a resilient member (110) in the form of a leaf spring.

6. A cam follower as claimed in any one of Claims 1 to 5 characterised in being formed at least in part from Fibre Reinforced Plastic material.

7. A valve mechanism including a cam follower mechanism as claimed in any one of Claims 1 to 6.

Fig.1.

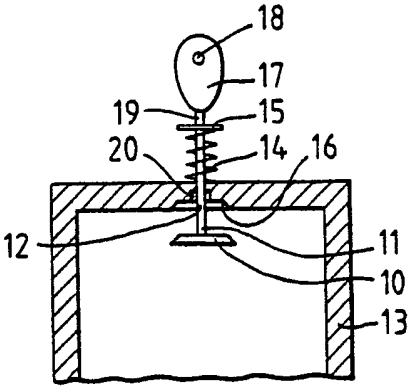


Fig.2.

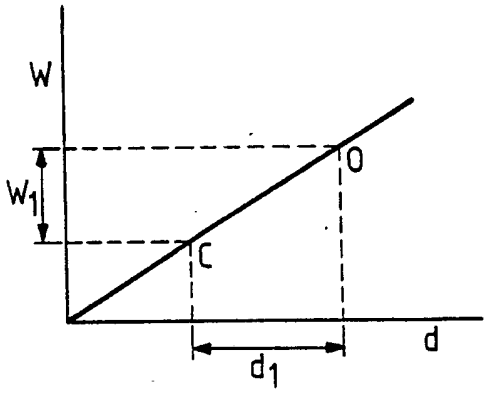


Fig.3.

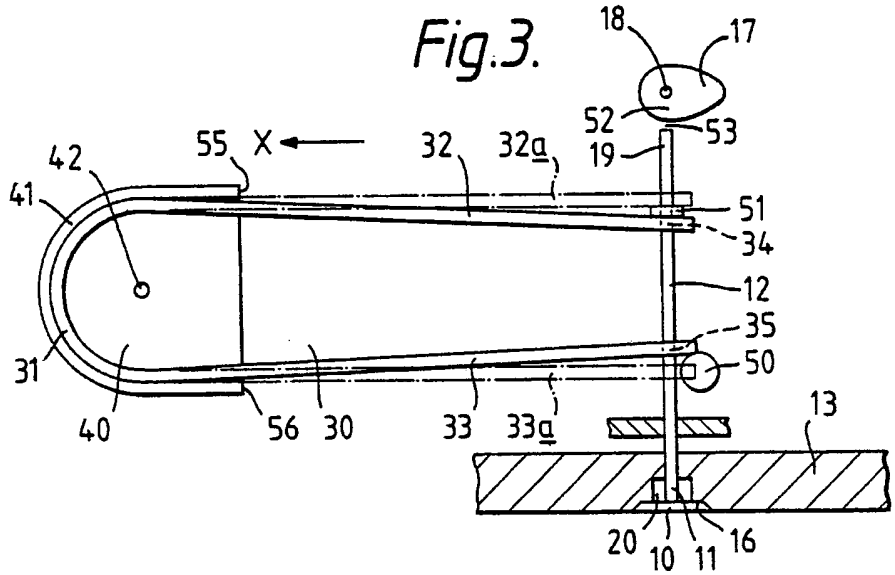


Fig.4.

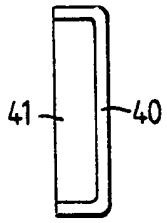


Fig.5.

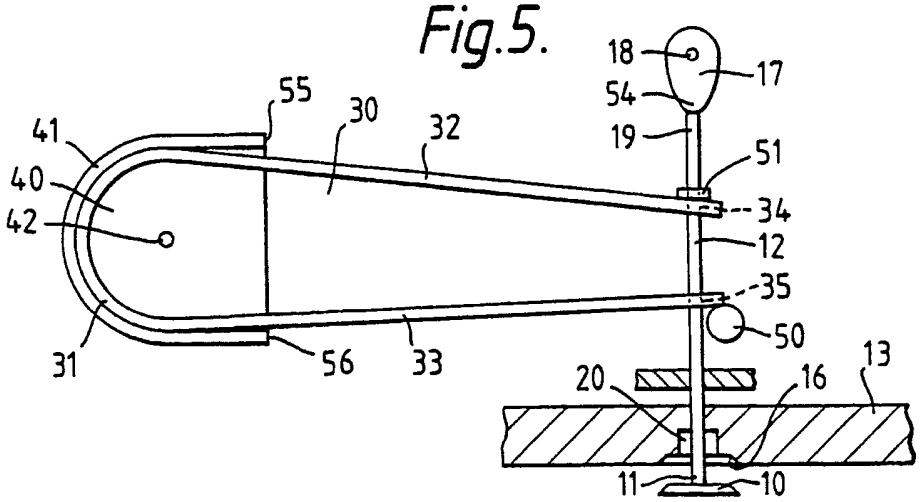


Fig.6.

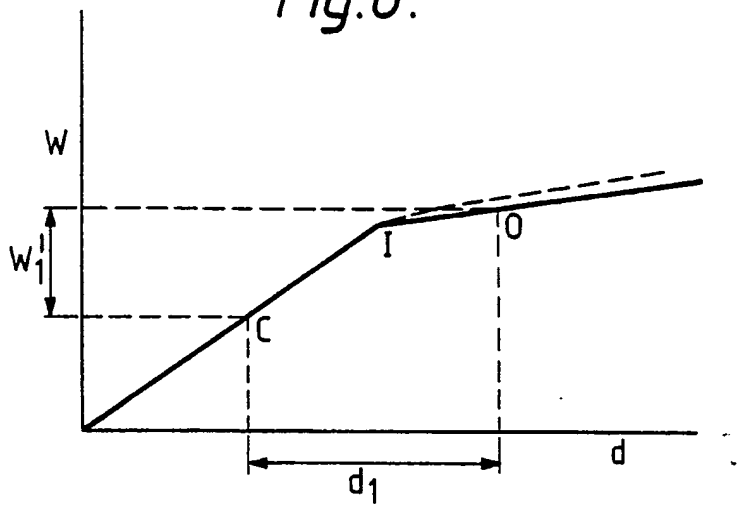


Fig.7.

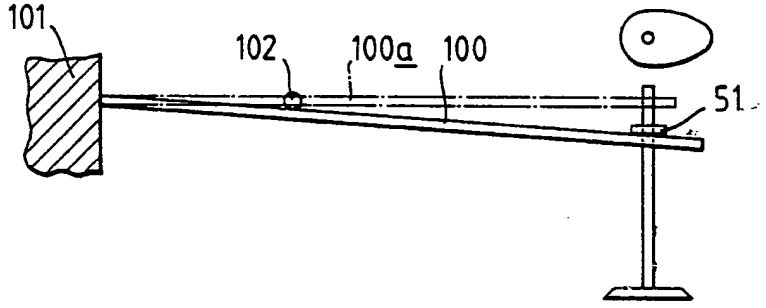
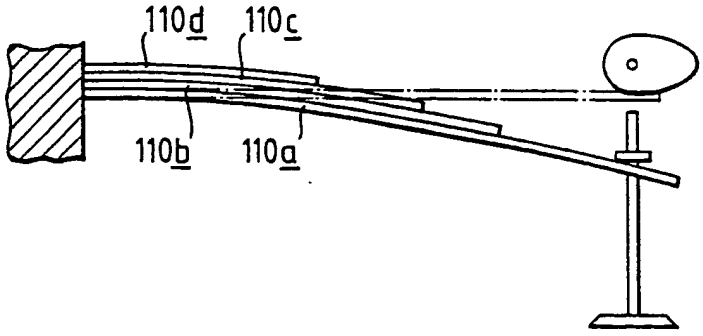


Fig.8.



INTERNATIONAL SEARCH REPORT

International Application No PCT/GB 86/00382

I. CLASSIFICATION OF SUBJECT MATTER (if several classification symbols apply, indicate all) [6]

According to International Patent Classification (IPC) or to both National Classification and IPC

IPC[4]: F 01 L 1/46; F 01 L 3/10; F 01 L 1/16

II. FIELDS SEARCHED

Minimum Documentation Searched [7]

Classification System	Classification Symbols
IPC[4]	F 01 L F 02 F

Documentation Searched other than Minimum Documentation to the Extent that such Documents are Included in the Fields Searched [8]

III. DOCUMENTS CONSIDERED TO BE RELEVANT [9]

Category *	Citation of Document, [11] with indication, where appropriate, of the relevant passages [12]	Relevant to Claim No. [13]
X	US, A, 4420141 (GOLOFF) 13 December 1983 see the abstract, lines 1-15; column 5, line 64 - column 6, line 36; figures 1,6,7	1,4,7
A	--	2,3
A	FR, A, 510643 (DAIMLER) 8 December 1920 see page 1, lines 24-58; figure 1	5
A	-- EP, A, 0005916 (GKN) 12 December 1979 see page 1, lines 1-4; figure 2	6
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* Special categories of cited documents: [10]

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"&" document member of the same patent family

IV. CERTIFICATION

Date of the Actual Completion of the International Search	Date of Mailing of this International Search Report
7th October 1986	31 OCT 1986
International Searching Authority	**Signature of Authorized Officer**
EUROPEAN PATENT OFFICE	I. VAN MOL

ANNEX TO THE INTERNATIONAL SEARCH REPORT ON

INTERNATIONAL APPLICATION NO. PCT/GB 86/00382 (SA 13856)

This Annex lists the patent family members relating to the patent documents cited in the above-mentioned international search report. The members are as contained in the European Patent Office EDP file on 15/10/86

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Patent document cited in search report	Publication date	Patent family member(s)	Publication date
US-A- 4420141	13/12/83	None	
FR-A- 510643		None	
EP-A- 0005916	12/12/79	GB-A- 2021731	05/12/79
		AU-A- 4692279	29/11/79
		JP-A- 54158562	14/12/79